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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|---------------------------|------------------|
| 10/673,605 | 09/29/2003 | Kum Foo Leong | 884.A68US1 | 2399 |
| 7590 | 09/01/2004 | | | |
| Schwegman, Lundberg, Woessner & Kluth, P.A. P.O. Box 2938 Minneapolis, MN 55402 | | | EXAMINER PAREKH, NITIN | |
| | | | ART UNIT 2811 | PAPER NUMBER |

DATE MAILED: 09/01/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|-------------------------------|------------------------------|---|
| Office Action Summary | Application No. 10/673,605 | Applicant(s) LEONG ET AL. | |
| | Examiner Nitin Parekh | Art Unit 2811 |  |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 August 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-19 and 28-39 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-19 and 28-39 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restriction

1. Applicant's election without traverse of Group I, claims 1-19 and 28-30 in Paper No. 3 is acknowledged.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-5, 8, 9, 12-14, 16, 18, 19 and 31-39 are rejected under 35 U.S.C. 102(b) as being unpatentable over Marlin (US Pat. 6429046) in view of admitted prior art (APA).

Regarding claims 1-5, 8, 9, 12 and 13, Marlin et al. disclose a flip chip bumped device having a plurality of solder bumps/balls on respective under bump metal (UBM) pad structure (Fig. 1-6; Col. 1, lines 20-25; Col. 1, line 55- Col. 3, line 18) comprising:

- a flip chip substrate/FCS (see 102 in Fig. 5 and 6) including a first major/top surface and a second/bottom major surface

- the UBM pad structure including pads/array of pads being made of an electrically conductive/metal material (302/304/308 in Fig. 5 and 6) on a copper pad (see 104 in Fig. 5 and 6; Col. 1, line 60) and being positioned on the first/top surface, the UBM pad structure (302/304/308 in Fig. 5 and 6) comprising a plurality of layers including:
 - o an oxidation/diffusion retarding layer (304 in Fig. 5; Col. 2, lines 33-36) made of a material such as nickel to retard the rate of oxidation/diffusion of species/electrically conductive material from the pad structure
 - o an adhesion/binding/non-wettable layer (302 in Fig. 5 and 6) for binding the oxidation retarding layer to the conductive material of the pad, the adhesion/binding/non-wettable layer including titanium (Ti) or titanium-tungsten (Col. 2, lines 5-15), and
 - o a solder support/receiving layer (308 in Fig. 5 and 6) such as gold (Col. 2, line 61) being placed on the oxidation/diffusion retarding layer
- the above UBM structure providing the layers/means to retard diffusion of copper and that for adhering/binding the pad, and
- a solder bump/ball (310 in Fig. 5 and 6) being attached to the copper pad, the solder including a tin (Sn) based lead-free solder (Col. 2, line 19)

(Fig. 5/6; Fig. 1-6; Col. 1-3).

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Marlin fails to explicitly teach the device having the pads being in a form of a ball grid array (BGA).

APA teaches conventional flip chip device being in a conventional BGA configuration (see specification pages 1 and 2).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the flip chip device being the BGA device as taught by the APA so that the desired interconnect density can be achieved and processing can be simplified in Marlin's device.

Regarding claims 14, 16, 18, 19 and 31-39, Marlin and APA teach substantially the entire claimed structure as applied to claim 1 above.

4. Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marlin (US Pat. 6429046) and APA as applied to claim 1 above, and further in view of Andricacos et al. (US Pat. 6224690).

Regarding claims 10 and 11, Marlin and APA teach substantially the entire claimed structure as applied to claim 1 above, except the binding layer having a thickness in a range of 80- 120 nm or 90-110 nm respectively.

Andricacos et al. teach a flip chip/BGA device having an UBM structure, the UBM structure including conventional adhesion/binding layers comprising titanium, chromium,

etc., the adhesion/binding layer having a thickness of about 100 nm to provide the desired adhesion and barrier properties (Col. 4, lines 45-55).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the binding layer having a thickness in a range of 80-120 nm or 90-110 nm as taught by Andricacos et al. so that the binding/adhesion can be improved in the APA and Marlin's device.

5. Claims 6, 7, 15 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marlin (US Pat. 6429046) and APA as applied to claims 1 and 14 above, and further in view of Andricacos et al. (US Pat. 6224690) and Okamoto et al. (US Pat. 5521438).

Regarding claims 6 and 7, Marlin and APA teach substantially the entire claimed structure as applied to claim 1 above, except the diffusion-retarding layer including Kovar or a composition 54Fe-29Ni-17Co respectively.

Andricacos et al. teach the flip chip/BGA device having a variety of configurations of the UBM structure including a configuration where a layer comprising nickel or a nickel alloy such as FeNi (see Fig. 2b) is used between the binding layer and solder receiving layer for a lead-free solder to provide the adhesion and to prevent further diffusion of an intermetallic (Col. 8, lines 1-37).

Okamoto et al. teach using soldered connections comprising terminals/electrodes made of conventional Fe-Ni based alloys including commercially available Kovar and low thermal expansion Kovar, such Fe-Ni-Co alloys having different wt.%/amount of Ni, Fe and Co (Col. 6, lines 65- Col. 8, line 65) to provide the desired joining strength, reduced thermal stress and improved reliability (Col. 6-12).

Furthermore, determination of parameters such as wt%/amount of various components, number of components, etc. in an alloy composition in chip packaging and interconnect technology art is a subject of routine experimentation and optimization to achieve the desired final properties such as bonding strength, adhesion, diffusion resistance, etc.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the diffusion retarding layer including Kovar or a composition 54Fe-29Ni-17Co as taught by Andricacos et al. and Okamoto et al. so that the diffusion resistance and adhesion/bonding can be improved in the APA and Marlin's device.

Regarding claims 15 and 17, Marlin, APA, Andricacos et al. and Okamoto et al. teach substantially the entire claimed structure as applied to claims 14 and 1 above.

6. Claims 28-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marlin (US Pat. 6429046) and APA and as applied to claim 1, and further in view of Andricacos et al. (US Pat. 6224690) and Shimokawa et al. (US Pat. 2002/0163085).

Regarding claims 28-30, Marlin and APA teach substantially the entire claimed structure as applied to claims 1 above, except the pad including an intermetallic compound including Ni-Sn/Ni₃Sn₄ and Ni-Fe.

Andricacos et al. teach the flip chip/BGA device having a variety of configurations of the UBM structure including a configuration where a layer comprising nickel or a nickel alloy such as FeNi (see Fig. 2b) is used between the binding layer and solder receiving layer for a lead-free solder containing Sn to provide the adhesion and to prevent further diffusion of an intermetallic (Col. 8, lines 1-37).

Andricacos et al. further teach intermetallics such as Ni-Sn being formed at an interface when elements such as Ni and Sn are present in the pad layers and the solder (Col. 5, lines 25-32). Shimokawa et al. teach intermetallic compound such as Sn-Fe being formed at an interface when elements such as Sn and Fe are present in the solder alloy and the solder alloy (Col. 5, lines 25-32).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the pad including the intermetallic compound including Ni-Sn/Ni₃Sn₄ and Ni-Fe as taught by Andricacos et al. and Shimokawa et al.

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so that the desired intermetallics remain adhered at the interface and further diffusion can be prevented in the APA and Marlin's device.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nitin Parekh whose telephone number is 571-272-1663. The examiner can normally be reached on 09:00AM-05:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Lee can be reached on 571-272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9318.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Nitin Parekh

PATENT EXAMINER

TECHNOLOGY CENTER 2800

NP

08-28-04